PHENIX
REQUIREMENTS FOR EQUIPMENT INTERLOCKS

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REQUIREMENTS FOR PHENIX EQUIPMENT INTERLOCKS

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REQUIREMENTS FOR PHENIX EQUIPMENT INTERLOCK SYSTEM
November 1999

This document defines and describes the requirements for the overall PHENIX interlock system and includes "specifics" related to the global interlock system, otherwise known as the Safety Monitor and Control System (SMCS).

1. INTRODUCTION

This document describes the interlock requirements for PHENIX which includes the Safety Monitor and Control System (SMCS) for the integrated PHENIX detector to be installed in the Experimental Hall at RHIC, Bldg. 1008. It is intended to provide information on the background and fundamental requirements that are necessary to execute the detailed design of the PHENIX Safety Monitor and Control System.

The PHENIX "SMCS" interlock system is designed to allow the PHENIX detector system to operate safely; it provides protection against major equipment damage, particularly that due to the effects of fire and water leakage.

The PHENIX detector includes eleven detector subsystems, plus three large analyzing detector magnets. Each of these has its particular safety hazards and precautions that must be recognized in the design of the global interlock system. Due regard must be taken to safeguard the operational integrity of these individual detector subsystems.

1.1 System Description, Configuration, Carriages, Etc.

Typically, each PHENIX subsystem and support system will have its own equipment interlock protection that will detect and react to hazards that are specific to that particular system or component (over current or over temperature, for example). These local interlocks are defined by the operating windows that have been covered in separate reviews.

The PHENIX Safety Monitor and Control System is mainly concerned with specific global hazards; signal inputs are as follows:

- Smoke and Fire Detection
- Flammable Gas Detection
- Water Leak Detection
- Emergency-off equipment protection (crash)
- Subsystem / Support System inputs

In the following sections, the implementation of these various inputs is specified. The nature of the hazard detection equipment is specified and the expected responses to

alarms generated by the detection equipment are given. These responses include automatic actions taken to reduce the hazard as well as communication and annunciation of the alarms to the principal control rooms.

1.2 Implementation.

Electrical interlocks shall be implemented using fail-safe hardware logic **for protection of equipment safety.** Relay logic, programmable logic controllers (PLCs) and other hardware logic may be used, but computer software (other than the PLCs) shall not be relied upon for the fail-safe operation of the safety system.
Computer programs, however, may be used for monitoring the status of interlock systems. Specifically, the EPICS-based software system that provides control and monitoring for the PHENIX detector system can be used to distribute status information. However, it will not be made an integral part of the PHENIX SMCS interlock system—i.e., it will not affect the fail-safe design of the SMCS interlock system.

The SMCS interlock system must remain fully functional when computer-based monitoring is not operational.

We have assumed the presence of a C-A Dept. Support Group at all times when PHENIX is in operation or when its systems are active.

1.3 RHIC – PHENIX Interlock Interface.

A RHIC safety interlock system, separate from the PHENIX SMCS interlock systems, provides both personnel and equipment safety. Protection to PHENIX personnel and access control to the PHENIX Experimental Hall, will be provided by RHIC and will be covered in the PHENIX operational readiness plan, which is outside the scope of this document.
There will be certain interconnections between the PHENIX and RHIC interlock systems, which will be defined in the course of developing the two systems. Before the PHENIX detector can start up, it must receive 'permission to operate' from RHIC.

2. FIRE DETECTION AND SUPPRESSION

Wherever possible the PHENIX detector uses non-flammable materials or materials that will not sustain a fire once the source of ignition has been removed. Materials of interest in this context include circuit board materials, cable insulation, non-metallic support structures, etc..

In spite of the best efforts in this regard, fires are possible within the PHENIX detectors electronics. Thus, one requirement of the PHENIX "SMCS" interlock system is to minimize the effects of fires by including sensors of adequate sensitivity, that detect the products of combustion promptly. In response to detection, the interlock systems shut down electrical power to the affected areas immediately, thereby removing the major source of ignition and, when appropriate, shut down sources of flammable gas as well.

In the following, the fire detection and suppression requirements of the PHENIX detector are discussed. Refer to Sect. 6 for the RHIC facility fire detection / suppression system.

2.1 PHENIX System Overview

2.1.1 Requirement

Fire detection and suppression systems dedicated to PHENIX are required.

2.1.1 Justification

The PHENIX detector is a multi-million dollar installation and, under DOE guidelines, must be protected from damage resulting from fire.

2.1.2 Design

PHENIX will use photoelectric type smoke detectors in each of the standard PHENIX electronics racks and HSSD type, aspirating smoke detectors elsewhere on the detector.

In addition, a separate fire suppression system is required for the Time of Flight (ToF) detector.

The local control panel for the PHENIX fire detection system will be located in the PHENIX Control Room (PCR). Fire alarms will be passed to the BNL Fire/Rescue Group via the Building 1008 fire alarm panel (FAP).?????? MCR ???????

Audible alerts will inform personnel when an alarm has occurred. PHENIX control room monitoring of alarm status will be achieved via a relay output signal from the SMCS to an annunciator panel located in the control room (PCR). Alarm status to the main control room (MCR) will be achieved via a relay output signal from the PHENIX SMCS to the VME PLC (108 subnet) located the rack room. ??????????????????????

2.2 PHENIX Control Room

2.2.1 Existing equipment

In the PHENIX control room, the existing RHIC safety system includes fire detection capability and a sprinkler system.

Shut down of AC power to this room in case of fire is by manual control—i.e., via a circuit breaker housed inside a local breaker panel.

2.2.2 Requirement

Since adequate fire detection and suppression already exist in the PHENIX control room, as part of the plant, no additional systems are required within the PHENIX SMCS interlock system.

2.2.3 Justification

Additional fire suppression for electronics equipment is not required since the value of the equipment housed in the control room is not expected to exceed 250K$.

2.3 PHENIX DAQ room

2.3.1 Existing Equipment

The DAQ room has an existing fire detection and sprinkler system which is a permanent part of the building. Shut down of AC power to this room in case of fire is by manual control - i.e., via a well identified and marked local breaker.

2.3.2 Requirement

Since adequate fire detection and suppression already exist in the PHENIX DAQ room, as part of the plant, no additional systems are required within the PHENIX SMCS interlock system.

2.3.3 Justification

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The electronics racks are grouped in rows in the DAQ room. Each rack meets the standard PHENIX design specification which requires that each to be fully enclosed with power interlocked upon high level detection from internal smoke, heat and water sensors. The smoke detectors will be spot type photoelectric with multi output alarm set-points.

As part of the Fire Hazard Analysis, PHENIX has agreed to further review DAQ equipment for dollar value and fire suppression needs.

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2.3.4 Design

Each smoke detector shall have at least two levels of alarm; a *low-level* and *high-level*.

The low-level gives an early indication of a developing problem or provides an indication of a malfunction. An operational procedure will be developed to provide an adequate response to such an alarm.

A high-level alarm is a clear indication of smoke in that enclosed volume.

2.3.4.1 Response to a low-level alarm

A low-level alarm from a smoke detector is annunciated to the PHENIX control room.

2.3.4.2 Response to a high-level alarm

Annunciation to the Fire Department. BNL Fire/Rescue Group responds.??????????????????

AC power, including UPS, to the specific DAQ rack is turned off automatically upon detection of a high level smoke alarm.

Building power and lights will remain on.

2.4 Carriage Racks

The electronics racks contain much of the supplemental electronics for the PHENIX detectors including power supplies, timing circuitry, etc. Racks are located on four vertical levels on the East carriage and only on the lowest level of the West carriage. Each rack is fully enclosed with sealed front and rear doors, and with cooling air circulating locally through heat exchangers connected to the cooling water system. Each rack is of the standard PHENIX design with internal interlock monitoring for high levels of smoke, temperature and water.

2.4.1 Requirement

A fire suppression system is not required inside the platform racks. Fire, heat and water leak detection interlocked to the AC power trip circuit is sufficient protection.

2.4.2 Justification

The value of the contents inside each rack is less than 250K$.

2.4.3 Design:

Detection as outlined below is common to each of the PHENIX electronics racks.

A multi level smoke detector and a heat sensor are used in each PHENIX rack to detect smoke and heat. In addition, a water leak detector is used to monitor internal coolant leaks.

2.4.3.1 Response to a low-level alarm

A low-level alarm from a smoke detector is annunciated to the PHENIX control room.

2.4.3.2 Response to a high-level alarm

A high-level alarm from smoke, heat or water results in the following actions:

- Automatic activation of a latching type magnetic contactor to shut off AC power to the individual rack. Access into the IR to reset the contactor (located inside the rack) is required to clear the interlock. The latching contactor cannot be reset by any remote means. Removing the AC power to racks removes the source of ignition.
- Annunciation of the alarm in the RHIC control room and the PHENIX control room. PHENIX control room personnel will respond appropriately following approved, written procedures.
- Annunciation of the alarm at the Fire Department. The BNL Fire/Rescue Group responds.?????????????
- Magnet power stays on.
- Building power and lights remain energized.
- UPS to the rack's internal computer / monitor remains on.

2.5 PHENIX Detector

It is deemed impractical to install a fire suppression system inside the full PHENIX detector. However, its construction materials are chosen to be non-combustible insofar as is practical. Thus, removal of sources of ignition will limit the spread of a fire.

Furthermore, the estimated time required for an emergency pump-out the RICH vessels is about 5 hours; thus, "emergency purge" or "emergency blow down" of any gas system will be Operator initiated and not automatic. Upon loss of power to the gas house, all flammable gas systems are designed to default into their "safe-state" which stops flow of flammable gas. ??????????????????

2.5.1 Requirement.

An aspirating type, high-sensitivity smoke detector is used for early warning detection in the local areas surrounding each major arm of the PHENIX detector. If smoke is detected, all experimental power is shut down and flammable gas systems will default to their safe states. Power to the three main detector magnets will also be automatically shut down.

Power that remains energized includes the gas mixing house general lighting circuit, the control room, the tech shops and the DAQ system, and the DAQ room.?????????????.

2.5.2 Justification

The construction of the PHENIX detector is accomplished with the use of non-flammable and non-fire-sustaining materials where possible. In addition, the main heat sources capable of causing fire in the detector are faults in the electrical system. By using materials that will not sustain a fire in the absence of a heat source, further damage to the PHENIX detector is limited once the AC power is removed.

2.5.3 Design:

The smoke detectors installed on the detector arms will be an aspirating type High Sensitivity Smoke Detector provided by the VESDA Company.

PHENIX is divided into four smoke detection zones; two for each of the detector's East and West carriage arms. Each of the four zones is designed for perimeter sampling around the adjacent detectors. An HSSD spot type smoke detector is also planned for the HVAC return duct plenum.???????????????? The input from each of these zones provides an independent input to the "SMCS" relay panel. The response actions to the high level smoke signals is the same for all four channels. The VESDA controller allows for high signal zone discrimination.

The VESDA HSSD smoke detector can be programmed to provide alarm / response actions at various levels. Initially, only low-and high-level alarms will be used.

The capability to shunt-trip experimental power at the AC breaker panels is provided for all power supplies feeding the PHENIX detector.

2.5.3.1 Response to a low-level alarm

Low-level alarms will be annunciated to the PHENIX control room. The appropriate response to such an alarm will be taken by the control room and support group personnel.

2.5.3.2 Response to a high-level alarm

In response to a high-level alarm, the following occurs:

- The alarm is annunciated at the PHENIX and RHIC control rooms.
- The alarm is annunciated at the Fire Department. The Fire/Rescue Group will respond ????????
- The alarm is annunciated to PASS. ????????
- The HVAC unit is turned off and the two E-fans are turned on ?????????????

- AC power to all PHENIX detector systems is automatically shut down to remove all possible sources of ignition. This includes all clean and dirty power to all experimental equipment. UPS remains energized. ?????????????
- The PHENIX magnets will be shut down.
- All flammable gas systems will automatically be placed into their "safe state". For PHENIX a safe state is one where flammable gas flow is stopped completely and, when appropriate, the inert gas component flows at normal rates. Emergency purge and emergency pump-outs of any chamber (including RICH) will be operator initiated. The operator will follow approved written Alarm Response Procedures after confirmation that an off-normal situation exists.

2.6 Magnet System

2.6.1 Requirement

Spot smoke detectors are required in the power-supply area.

Coil monitoring and voltage comparison will protect the magnets.

2.6.2 Justification

Common practice is to use facility spot smoke detection located physically above the power supplies.

2.6.3 Design

Building spot type smoke detectors will be located in the Cryogenic Support Building (1008B) where the magnet power supplies reside.

2.6.3.1 Response to high-level alarm

A high level alarm results in the following actions:

- The alarm is annunciated to the RHIC control room and the PHENIX control room.
- The alarm is annunciated to the Fire Department. The BNL Fire/Rescue Group responds.
- Building power, lights and emergency lighting remain on.
- Problems internal to the magnets themselves are monitored and interlocked to the power supplies via two independent systems. One is the hardwire relay system that monitors klixons, water mats, flow switches, etc. while the second is the PLC used to monitor and communicate real time magnet parameters including status, temperatures, flows, voltage, current and coil turn to turn

shorts. Both systems are an integral part of the magnet protection and power supply interlock system.

- The operators/watch will follow approved written Alarm Response Procedures after confirmation that an off-normal situation exists.

3. WATER LEAK DETECTION

Water cooling is used for most of the electronics in the PHENIX detector. In spite of the best efforts to design, build, and install a reliable water cooling system, the possibility of leaks must be anticipated and protected against. Depending on the size of the leak, damage to powered electronics from a water leak can be expected if the power is not removed quickly. Thus, a Tracetek leak detection system is planned as a means of global protection for the five major PHENIX detector arms. A Tracetek loop will be incorporated in each major arm. ???????The Tracetek loop is in addition to any sub-system water leak detectors; independent of the water leak detection housed inside every PHENIX rack; independent of the water mat detection used for each of the three large magnets; and, independent of the water leak detection used to monitor the magnet power supplies.

3.1 PHENIX Control Room

There is no water-cooled electronic equipment in the PHENIX control room. Thus, leak detection is not required.

3.2 PHENIX DAQ room

3.2.1 Requirement.

Leak detection is required in the PHENIX DAQ electronics racks

3.2.2 Justification

This equipment uses circulating air for direct cooling. The circulating air is cooled by a heat exchanger located inside each rack.

3.2.3 Design

Each DAQ rack has its own independent water detection monitor. “SMCS” does not monitor this circuit.

3.2.3.1 Response to faults

In response to detection of a water leak, the following actions occur:

1) AC power to the problem rack is immediately and automatically shut down.

2) Circulation of cooling water is shut down via manually operated shut-off valves clearly labeled and located on the south-west corner of the DAQ room.

3) The slow controls computer system is notified; it annunciates the alarm on the appropriate display inside the PHENIX control room.

4) Procedures will cover alarm investigation, confirmation, water shut-off sequence, and power shut down to the remaining DAQ racks. The operators/watch will follow approved written Alarm Response Procedures after confirmation that an off-normal situation exists.

3.3 Carriage Racks

3.3.1 Requirement

Leak detection is required in all PHENIX electronics racks.????????

3.3.2 Justification

This equipment uses circulating air for direct cooling. The circulating air is cooled via heat exchangers mounted inside each rack.

3.3.3 Design

Each rack will have its own water leak detector located inside the enclosure. The detection circuit will be tied into the latching magnetic contactor to automatically shut off all AC power to the rack upon detection of a water leak.

3.3.3.1 Response to fault

In response to the detection of a water leak, the following actions occur:

1. Power to the rack is automatically interlocked-off. UPS stays on. ????????????
2. Cooling water to the detector arm containing the problem rack will be shut off manually by remote solenoid valves. There is one solenoid valve on the water supply line and one solenoid valve on the water return line of each detector arm. ????????????????????????
3. An alarm signal will be annunciated in the PHENIX control room.

3.4 PHENIX Detector

3.4.1 Requirement

Leak detection and appropriate response is required for the PHENIX detector.

3.4.2 Justification

In addition to the main magnets (see below) cooling water is also used by various sub-systems to cool their electronics in each of the major arms.

3.4.3 Design

Five zones of a Tracetek system will be dedicated to the PHENIX detector, one for each of the main detector arms – North, South, East, West and Central. A loop of Tracetek will be placed along the base of each main detector arm to provide global monitoring of water leaks within that arm.?????????

3.4.3.1 Response to a fault

In response to the detection of a leak within a detector arm, the following actions occur:

- An alarm signal will be annunciated in the PHENIX control room.
- All experimental power remains on. Power shut-downs will be initiated by the control room Operator.
- The Watch group will be notified by the Control Room Operator and water shut down will be performed manually by them.
- Gas systems remain operational.
- Magnet power and cooling water stays on.

3.5 Magnet System

3.5.1 Requirement

Leak detection is required at each power supply and at the magnets themselves.

3.5.2 Justification

Cooling water is used for the magnet power supplies, for the magnet power buses, and for the coils of the magnet.

3.5.3 Design

Water leak detection in the power supplies is by means of water mats internal to the supplies. These are interlocked to the local magnet power supply interlock chain.

Water mats will also be used for water leak detection at each of the three magnets (i.e., North, South and Central). The magnet and power supply water mats are independent of each other and separate from the global, Tracetek monitoring system.

The magnet water cooling system has its own internal leak detection. The design of this internal leak system is based on the fact that the magnet water system is a closed loop system and, hence, in the absence of leaks the volume of water in the system is a constant. There is a “make-up” water tank incorporated in the system that will

supply water to the system in the event that the volume of water decreases. There are two levels of alarms that may be set, and monitored with this system. The first level of alarm is when the system has lost some selectable volume of water (e.g. 100 gallons) within a selectable period of time (e.g. ten minutes). The second level of alarm is when the system has lost a selectable volume of water (e.g. 150 gallons) within a selectable period of time (e.g. ten minutes), at which point the system shuts itself down. There is one additional diagnostic signal from this system. When the volume of water in the makeup tank has decreased by a selectable amount, a make-up solenoid opens and starts refilling the expansion tank at the rate of five gallons per minute. A signal can be monitored that indicates when make-up is in operation.

In the following, distinction is made between a "normal" fault (a slow water leak) and a "major" fault such as a blown cooling-water hose. A "major" fault is defined as a fault that is detected by the internal monitoring of the cooling water system, as described above. A "normal" fault, on the other hand, is defined as a leak that is detected by the Tracetek system (used to monitor sub-system and major arm water leaks) or water mats (used to detect magnet and power supply water leaks).

3.5.3.1 Response to a "normal" fault at the magnet power supplies

The response to detection of a leak at the magnet power supplies is handled by the magnet relay interlock and PLC monitoring system, not by the "SMCS**"**. The following actions occur:

1) The magnet power supply is automatically shut down.
2) The PHENIX magnet control system is notified through the magnet PLC and an alarm is annunciated in the PHENIX control room
3) Operator and Watch to follow approved, written Alarm Response Procedures for water and power turn-off procedures.

3.5.3.2 Response to "normal" water leaks at the magnets

The response to detection of a leak at the magnets is handled by the magnet relay interlock and PLC monitoring system, not by the "SMCS**"**. The following actions occur:

1) The magnet power supply is shut down.
2) The PHENIX magnet control system is notified through the magnet PLC and an alarm is annunciated in the PHENIX control room.
3) Operator and Watch to follow approved, written Alarm Response Procedures for water and power turn-off procedures.
4) Gas system power is not shutdown automatically and the gas systems are not purged automatically.
5) Power and water to each subsystem on the main detector arm is not shutdown automatically.

3.5.3.3 Response to "major" water leaks

In response to detection of a large water leak fault, equivalent to a blown cooling water hose, the following actions are initiated via the cooling water system:

1) The magnet PS is shut down automatically. This action is taken via a signal passing between the water system interlock system and the magnet interlock system, not by the SMCS.
2) The Magnet cooling water system is shut down automatically. This action is taken by the water system PLC based interlock system, not by the SMCS.
3) All power to the five main detector arms is shut down automatically. This action is taken by the SMCS via a hard wire link between the water system PLC and the SMCS. This removes power from all of the electronic racks, the detector mounted electronics, and all high voltage systems. ???????????????
4) Gas system power is not shutdown automatically and the gas system is not purged automatically.

4. FLAMMABLE GAS DETECTION

Current plans for the physical construction of detector assemblies in the PHENIX detector include the use of the following types of gases:

Subsystem	*Gas of Choice*	*By / Type*	Total Volume	OP Flow
DC	50/50 Ar / Et	PNPI – Recirc. (*)	(2) 5.6M3	5 l/min/per
PCs			(40) 1M3	1 l/min/per
TEC	P10	PNPI – Recirc. (*)	(24) 6M3	1 l/min/per
RICH	Ethane	BNL – Once through	(2) 80M3	3 l/min/per
MuTr	25/75 Iso/Freon	BNL – Recirculating	(6) 4.5M3	8 l/min/per
MuId	9/91 Iso/CO2(**)	BNL – Once through	(60) 50M3	0.5 l/min/per

(*) This gas delivery is similar to that used at STAR on the TPC.
(**) Component is flammable but the mixture is not.

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The PHENIX gas detection system is for equipment safety. RHIC will provide a system for personnel safety (Refer to Sect 6).

4.1.1 Justification

As significant quantities of flammable gas will be used in the PHENIX detector, a gas detection system is required.

4.1.2 Design

An air sampling type system is to be provided. In response to a high level (25% LEL) gas alarm, which is annunciated in the PHENIX control room, "SMCS" will typically shut down experimental power, magnet power and the flow of flammable gas to all five detector arms. All detector gas systems will default to their safe state (i.e., flammable gas off / inert gas flowing at normal flow rates). Emergency purge or emergency blow-down of gas systems will not be initiated automatically. Operators will follow approved, written Alarm Response Procedures for all emergency purge and blow-down response actions.

4.2 PHENIX Control Room

Flammable gas detection is not needed in the PHENIX control room, since no gas equipment is in that room.

4.3 PHENIX DAQ room

Flammable gas detection is not needed in the PHENIX DAQ room, since no gas equipment is in that room.

4.4 Carriage Racks

The carriage racks do not contain and, thus, are not monitored internally for flammable gas.

4.5 PHENIX Detector

A flammable gas detection system is required because of the use of flammable gas components in various subsystem detector chambers.

4.5.1 Requirement

A flammable gas detection system is required to be in place and operating at all times when flammable gas is present in any detector located in the IR area of the PHENIX Experimental Hall. Potential future requirements for use of limited quantities of flammable gas in the Assembly Building are considered to be outside the scope of this document and will be presented at a later date.

4.5.2 Justification

The possibility of a gas leak from any PHENIX subsystem detector or chamber results in the requirement for flammable gas detection.

4.5.3 Design

For monitoring gas leaks within the detector, an air sampling system will be used. Two independent controllers will be utilized; one on the East Arm and one on the West Arm. Each controller will monitor the radial gaps adjacent to the windows of those detectors that contain flammable gas. Since air flow patterns are unpredictable, four of the eight sensors will be mounted high (above the gaps) while the remaining four will be mounted low (below the gaps).

In addition to the "in close" monitoring on the carriage arms, above, a duct type catalytic gas detector will be installed inside the HVAC return plenum duct.

The input from each of these zones constitutes an independent signal input to its controller which will deliver a high alarm signal to the "SMCS".

4.5.3.1 Response to low-level alarm

In the event of a low-level alarm, the following actions are taken:

1) The PHENIX control room is notified through the annunciator panel

4.5.3.2 Response to high-level alarm

In the event of a high-level alarm, the following actions are taken:

1) All power to the PHENIX detector arms (zones) is automatically shut down. This removes power from all of the detector mounted electronics and high voltage systems.
2) The magnet power is shut down.
3) UPS power inside all detector racks is turned off; other UPS not feeding Cl I, Div. II equipment will be turned off automatically.
4) Power to the High Capacity Vent Stack and Low Capacity Vent Stacks remains on.
5) HVAC turned off / E-fans turned on (PASS)????????
6) The Subsystems using flammable gas are sent into their "safe state".????????

7) The PHENIX control room is notified.

8) The RHIC control room is notified.

9) The Fire Department is notified and responds.

10) Building ceiling lights remain on.

11) Power to the Gas House goes off but lights remains on??????

12) Power to the Counting House and DAQ room remains on.

13) Operators will follow approved, written Alarm Response Procedures for other remote shut-downs as deemed necessary for a particular run or run configuration.

Identification and location of all "exempt" power listed above will be documented and available through the PCR.

4.6 Magnet System

Flammable gas detection is not needed in the magnet system, since it uses no gas.

4.7 The Gas Mixing House

A four zone catalytic type gas detection system will be used in the equipment room of the Gas House.

4.7.1.1 Response to low-level alarm

In the event of a low-level alarm, the PHENIX control room is notified through the annunciator panel.

4.7.1.2 Response to high-level alarm

1.) Power to the equipment room of the Gas House is shut down putting all flammable gas systems into their safe state.

2.) Power in the Gas House monitor room remains on .???

3.) The PHENIX control room is notified.

4.) The RHIC control room is notified.

5.) The Fire Department is notified.??????????

6.) Power to the Counting House and DAQ room remains on.

7.) Operators will follow approved, written Alarm Response Procedures for other remote shut-downs as deemed necessary for a particular run or run configuration.

5. POWER EMERGENCY-OFF SYSTEM

The power emergency-off ("crash") system is intended for the emergency use by personnel who detect hazardous conditions that require immediate action. Clearly labeled manually operated power emergency-off buttons are to be located strategically throughout PHENIX.

The PHENIX power emergency-off system is interlocked to the AC power distribution system via shunt-trips which can force circuit breakers to open, thereby positively removing electrical hazards. Power shut down also places all flammable gas systems in their "safe state". Emergency purge or blow down of flammable gas systems can be initiated by the Operator following approved, written Alarm Response Procedures.

All emergency-off "crash" buttons associated with the PHENIX safety interlock system shall be clearly labeled to be easily distinguishable from the emergency-off buttons associated with the RHIC / PASS interlock system.

Operation of the power "crash" button results in a complete shutdown of the PHENIX detectors (power and gas) and associated equipment, including magnet power, cooling water, rack pressurized air, and the power to the equipment room of the PHENIX Gas House.

Power that is not shut off includes:

1. Power to the High Capacity Vent Stack and Low Capacity Vent Stacks.
2. Building ceiling lamps in the IR.
3. HVAC stays on / E-fans stay off
4. Lighting circuit in the monitor room of the Gas House.
5. Power to the Counting House and DAQ room stays on.

The source, control and location of "exempt" power to the above equipment will be identified, labeled and recorded with control room Operators and Watch should the need arise to isolate or shut-down these sources of power.

5.1 PHENIX Control Room

5.1.1 Justification

To provide hardware protection in emergencies where immediate action is imperative. The use of the crash button provides a complete shutdown of PHENIX and is a last resort “panic button”.

5.1.2 Design

As a minimum, one power emergency-off button is to be installed in the PHENIX control room. Refer to Section 5.0, above, for shutdown response actions.

The emergency off crash buttons supplement the already existing shunt trip breaker panel located in the PCR (shuts down power to any one or all 5 main detector arms).

5.2 PHENIX DAQ Room

5.2.1 Requirement

There is no requirement for an emergency-off button in the DAQ room.

5.2.2 Justification

Local circuit breaker panels are in close proximity and provide sufficient protection against electrical hazards in this room. Circuit breakers, for electronics racks that are located in the DAQ room, will be properly labeled and readily accessible for power shutdown.

5.3 Carriage Racks

5.3.1 Justification

To provide hardware protection in emergencies where immediate action is imperative. The use of the crash button provides a complete shutdown of PHENIX and is a last resort “panic button”.

5.3.2 Design

A power emergency-off button will be located on each level of the carriage rack platforms on each main detector arm (North, South, East, West and Central) to initiate a complete PHENIX shutdown. Refer to Section 5.0, above, for shutdown response actions.??????????????????????

5.4 PHENIX Detector

5.4.1 Justification

To provide hardware protection in emergencies where immediate action is imperative. The use of the crash button provides a complete shutdown of PHENIX and is a last resort "panic button".

5.4.2 Design

At least two emergency-off buttons will be located around the perimeter of the detector in the IR; one at each exit. Refer to Section 5.0, above, for shutdown response actions.

5.5 Magnet Power Supply Systems

5.5.1 Requirement

An adequate number of emergency-off buttons near the magnet power supplies is required for local shutdown of said power supplies which are located in the Cryo Support Building of 1008B.

5.5.2 Justification

The emergency-off buttons are needed to provide hardware protection in the event of a system malfunction.

5.5.3 Design

Activation of these local magnet power supply emergency-off buttons will immediately shut down AC power to the magnet power supplies via hardwire relay interlocks to the power supplies. This is not part of the SMCS interlock system and will not initiate a complete PHENIX shut-down or crash.

5.6 Gas Mixing Room

The emergency power-off button in the equipment room of the Gas House will shut down power to the gas systems putting them into a default mode, safe state. Only power feeding the equipment room will be affected by this action. The building exhaust fan and monitor room lighting circuits will remain energized.

Upon loss of power, all flammable gas systems are designed to default to their "safe-state" which stops flow of flammable gas and, for all detectors with flammable gas components, allows continued flow of inert gas into the chambers.

Activation of this local interlock will shut-down power (and gas flow) in the gas house but will not initiate a complete PHENIX shut-down or crash.

When required, Operators will follow approved, written Alarm Response Procedures for all emergency purge and blow-down responses.

6. RHIC SYSTEMS

6.1 Fire Detection

6.1.1 Gas Mixing room

Fire detection in the gas mixing room is the responsibility of the RHIC safety systems. Removal of AC power puts all flammable gas systems into their "safe state" and removes all sources of ignition. Utility lights in the monitor room will remain on.

6.1.1.1 Recommendation

Spot type heat and smoke detection should be interlocked to the equipment room AC power circuit.

6.1.1.2 Response to high-level alarm

A high level alarm from a detector results in the following actions:

1) A shunt-trip of all AC power to the equipment room of the Gas House. Removing the AC power removes sources of ignition, places flammable gas systems into their "safe state" and allows safe access for Fire Department personnel.

2) The alarm is annunciated in the RHIC control room and the PHENIX control room.

3) The alarm is annunciated to the Fire Department. The BNL Fire/Rescue Group responds.

6.1.2 RHIC Facilities

The RHIC facility in the IR of Bldg. 1008 has two independent fire detection systems:

The first is identified as Zone #2 which includes the ceiling spot ionization smoke heads and rate of rise heat detectors. Zone #2 devices are used as the "charge" mechanism for the pre-action sprinkler suppression also located at ceiling height.

The second is identified as Zone #3 and includes the HSSD aspirating smoke detectors that are also ceiling mounted. Although Zone #3 is currently limited to the IR region

of the PEH, plans are underway to extend this system into the Assembly Area in the near future.

Fire Alarm pull stations and portable fire extinguishers currently exist near exits to the area and at other prominent locations. The PHENIX detector does not shutdown automatically if a fire alarm is pulled.

6.2 Flammable gas Detection

6.2.1 RHIC Facilities

Flammable gas detection systems are planned for the Interaction Region (IR) of the PHENIX Experimental Hall (PEH) at Bldg. 1008. These detectors along with the emergency exhaust fans are controlled through PASS. It is beyond the scope of this document to describe the RHIC/PASS gas detection system.

6.2.1.1 Recommendation

A system to detect flammable gas in the IR portion of the PEH is required for PHENIX operation as a RHIC detector. This system is being provided by the RHIC PASS System. Future requirements, associated with the Assembly Area of the PEH, are outside the scope of this document and will be addressed at a later date.

6.2.1.2 Justification

There is potentially flammable gas in the IR because of the gas used in various subsystem detector chambers.

6.2.1.3 Design

In the event of the detection of flammable gas by PASS within the IR, the following actions should be taken:

1) The remote AC breaker for the Gas House (equipment room) is shunt-tripped. This results in gas systems being placed in their “safe state”; Operators will follow approved, written Alarm Response Procedures for all emergency purge and blow-down response actions, if required.

2) The remote AC breakers for all PHENIX detector power is shunt-tripped to eliminate spark hazards. ?????????????

3) The event is annunciated to the PHENIX control room, the RHIC control room and the BNL Fire/Rescue Group.

4) Exhaust fans are activated while the HVAC unit is turned off.??????????????????????

5) Building lights remain on.

6) The magnet power is shut down.

6.2.2 Gas Mixing Room

Flammable gas detection in the Gas House will be provided by PHENIX and interlocked with the detector gas systems as outlined in Sect. 4.7, above.

6.3 Emergency Power off buttons

RHIC / PASS system emergency-off buttons in the PEH and tunnel areas are primarily intended as a radiation safety system. The safety interlocking within the RHIC facilities is under the purview of the RHIC safety systems and is therefore not detailed by this document.

6.4 Leak Detection

6.4.1 Gas Mixing Room

There are no requirements for water leak detection in the Gas Mixing Room.

6.4.2 RHIC Facilities

There are no requirements for water leak detection in the PHENIX Experimental Hall.

7. SMCS RELAY SYSTEM

Currently, we have a total of 50 relays. Each relay has 1 input and 8 outputs. Five (5) of the 8 outputs are available for our use (three output signals are reserved for internal control and annunciation).

Thus, we have 50 relays providing a total usable capacity of 50 inputs and up to 250 output action options.

7.1 Inputs to the "SMCS" System: ??????????????

(1) PASS (Gas) (one input for both divisions)

(2) Facility Fire Alarm Panel- FAP (Zone 2 and Zone 3)

(6) "SMCS" - Gas Alarm Panel (one for each major arm + IR)

(7) "SMCS" - PHENIX FAP (one for each major arm + IR + ToF)

(6) "SMCS" – Power Emergency Off – CRASH (each major arm + IR)

(5) Subsystem L3 alarm input - via its PLC (each major arm)

(5) Support System L3 alarm input - via its PLC
- gas vent fans
- loss of purge air pressure
- loss of cooling water system
- etc.

Thirty two (32) inputs in use and eighteen (18) spares remaining.

7.2 "SMCS" Emergency Response Output Actions:????????????

Options can be individual or in combination.
- Shut off power to one or all detector arms
- Shut off power to one or all magnet power supplies
- Shut off specific PEH Building power (excluding lights)
- Shut off power to the Gas Mixing House (excluding lights)
- Shut off HVAC
- Turn on Emergency Exhaust Fans
- Communications to PASS / FAP / MCR / PCR

8. RESPONSES TO THE PHENIX "SMCS" INTERLOCK SYSTEM

?????? info from Paul ???????